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ABSTRACT

This monograph, one in a series describing innovative educational practice, presents a case study of the Tools of the Mind project. This project, the result of collaboration between Russian and American education researchers, used the Vygotskian approach to create a series of tools or strategies for teachers to use in supporting the development of early literacy, including meta-cognitive and meta-linguistic skills as well as other foundational literacy skills. The monograph describes the development and piloting of the project, including the creation of the Early Learning Advisor, a computerized assessment system that provides direct advice to teachers on the developmental levels of their individual students, and gives them suggestions about how to apply the innovative teaching concepts in their daily work in the classroom. The monograph also discusses an empirical evaluation of the project, which revealed that the strategies had a positive effect on literacy achievement in young children. (Contains 24 references.) (EV)

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TOOLS OF THE MIND: A CASE STUDY OF IMPLEMENTING THE VYGOTSKIAN APPROACH IN AMERICAN EARLY CHILDHOOD AND PRIMARY CLASSROOMS

Elena Bodrova and Deborah J. Leong

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TOOLS OF THE MIND:

A CASE STUDY OF IMPLEMENTING THE VYGOTSKIAN APPROACH IN AMERICAN EARLY CHILDHOOD AND PRIMARY CLASSROOMS

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Elena Bodrova, Ph.D., and Deborah Leong, Ph.D., have collaborated since 1992 when Dr Bodrova came to the United States from the Russian Federation, where she had worked at the Institute of Pre-School Education and the Centre for Educational Innovations. They co-authored one of the defining books on Lev Vygotsky's educational theories, *Tools of the mind: The Vygotskian approach to early childhood education* (1996, Merril/Prentice Hall) and four educational videos (Davidson Films). Dr Bodrova is currently working for Mid-Continent Research for Education and Learning (McREL), Colorado. Dr Leong is a professor at Metropolitan State College of Denver since 1976. She has also co-authored a college textbook: *Assessing and guiding young children's development and learning* (1997, Allyn & Bacon).

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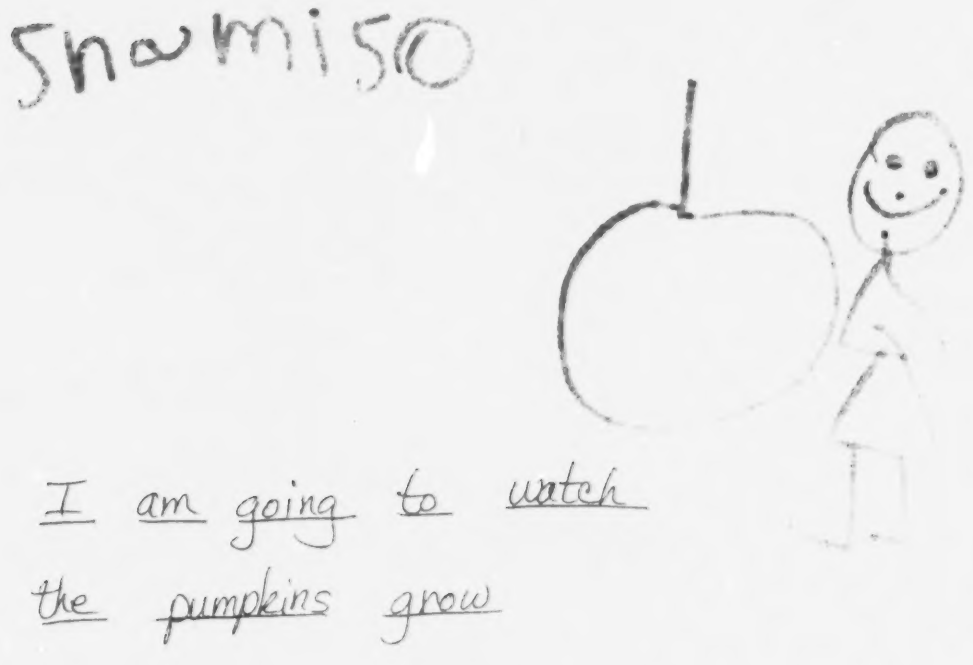
Foreword

The Tools of the Mind project aims to foster the cognitive development of young children in relation to early literacy learning. The authors of the project have developed a number of tools to support early learning and a highly innovative method for training teachers in using these approaches. Piloting of the approaches has demonstrated their potential to develop children's early literacy skills and they are being increasingly used in early childhood education programmes across the United States. The project is the result of collaborative work between Russian and American education researchers, based on the theories of Vygotsky, applied to the cultural context of the United States. This monograph describes the development and piloting of the project, including the creation of the Early Learning Advisor, a computerized assessment system which provides direct advice to teachers on the developmental levels of their individual students, and gives them suggestions about how to apply the innovative teaching concepts in their daily work in the classroom.

FIGURE 1. Play plan by Shamiso in November



Introduction

The Tools of the Mind project began as a search for tools to support the cognitive development of young children. We ended up focusing on the development of a number of teaching tools to scaffold early learning and a unique method of training teachers in how to use these tools. On the basis of the Vygotskian approach, we created a series of tools or strategies to support the development of early literacy, including meta-cognitive and meta-linguistic skills as well as other foundational literacy skills. The results of an empirical evaluation of the project revealed that the strategies had a positive effect on literacy achievement in young children.

As the project grew, so did the number of teachers who wanted to be trained in how to implement these innovative strategies. The traditional workshop/class format we used to train teachers was not as effective as we wanted it to be—something that other researchers in staff development have also discovered. In response to this, we took a unique approach to teacher training by using child assessment and technology to transfer expert knowledge to the classroom teacher. With Dr Dmitri Semenov, an expert in mathematical modelling of psychological processes and design of artificial intelligence systems, we developed a diagnostic-prescriptive computerized assessment system—the Early Literacy Advisor (ELA). The ELA acts as an 'expert teacher' capable of giving advice on how to address the specific instructional needs of an individual student. Consequently, instead of general workshops on literacy development, teachers are given specific results from the assessments of their own students described in terms of the relevant developmental patterns. Instead of a workshop on literacy activities, the assessment results include the literacy activities most suitable for the children in their classroom. And instead of lectures on the Vygotskian approach, teachers learn about the concepts of *zone of proximal development* and *scaffolding* as they apply them in their own teaching. At many levels, the ELA was able to break down barriers to innovation.

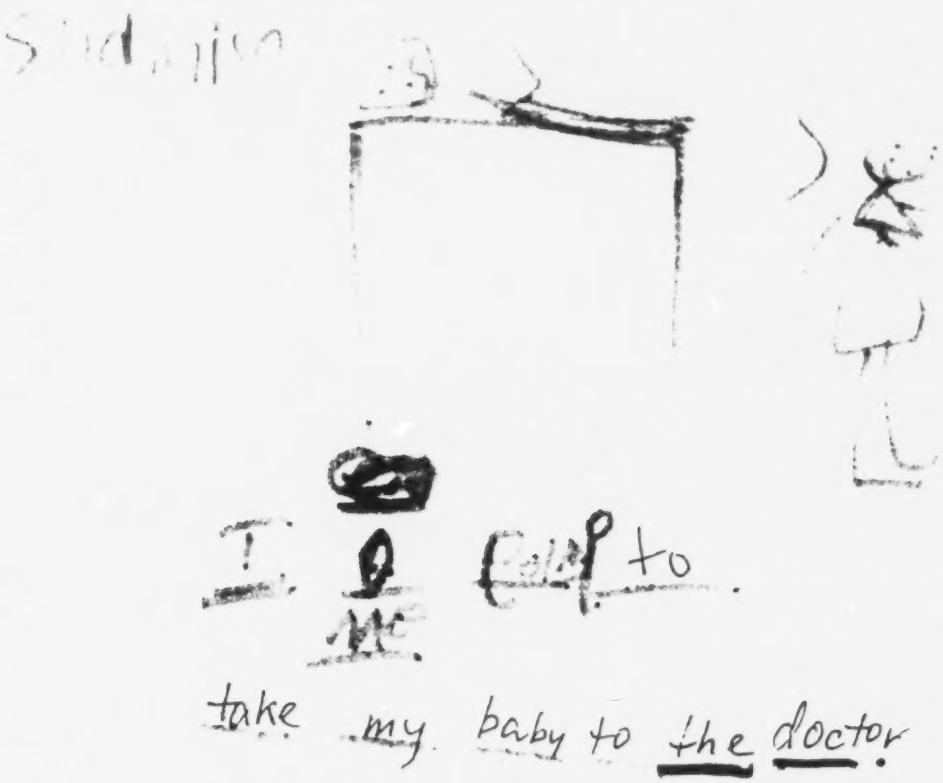
The Tools of the Mind project began in two classrooms with three interested teachers. It has grown over eight years to influence hundreds of teachers and their students through educational videos, books, articles and the use of the ELA.

We believe that this project demonstrates that good educational practices originating in one country can spark the creation of new practices that fit the cultural context of another country, but still remain faithful to the theoretical foundations underlying the original. The results can be extremely positive and

unique—something that would not have been developed in either country without the exchange of ideas. A necessary ingredient for innovation is the thoughtful exchange between researchers and practising teachers so that the newly developed instructional practices can address critical learning problems in a way that the teacher can easily implement in the classroom. In our case, two early childhood teachers in particular—Ruth Hensen and Carol Hughes—made this possible. We have seen many programmes that try to adapt the classroom to the innovation instead of developing the innovation to fit the structure and organization of the classroom. An innovation cannot survive unless empirical research is used to validate the effects of the newly developed tools. Dissemination and evaluation go hand in hand.

The INNODATA programme is designed to foster the kind of cross-fertilization embodied in Tools of the Mind by providing a forum to share the experiences of researchers who have tried to implement and evaluate these kinds of innovative programmes. We hope that our experience will be useful to other researchers struggling with similar problems and issues.

FIGURE 2. Play plan by Shamiso in February



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National/regional and local contexts in which the innovation was conceived

The Tools of the Mind project was conceived at a time when a national consensus was already established about the importance of early childhood education. Recognizing the need to increase the quality of these programmes, the National Association for the Education of Young Children (NAEYC) began to accredit early childhood education programmes, using the idea of developmentally appropriate practice as its core. Developmentally appropriate practice is instruction that is both age and individually appropriate (Bredekamp & Rosegrant, 1992). As programmes adapted to obtain the NAEYC accreditation, this very broad definition of instructional practice led to several problems. First, most teachers did not have enough knowledge about child development to be able to practically decide what to do in the classroom. In addition, the research base used to define developmental patterns was being modified at a rate that only academic experts in the field could keep up with. Second, the broad and open-ended nature of the definition was subject to a wide variety of interpretations—for some it meant no teaching at all and for others it meant very teacher-directed instruction.

At about the same point in time, the spotlight of accountability hit elementary schools in the United States. The standards-based movement was the result of the American public's growing dismay over the low levels of achievement of American students in general and specifically on international tests in maths and literacy. Schools in the United States have always been under the control of local communities, so that what children learned was primarily determined by local (city or county) school boards. Therefore, goals for student achievement have not been set at a national level. Many people suspected that the variability in objectives was a major cause of stagnant and often dismal test scores, so many states began to set standards, to assess children and to hold school districts, schools and teachers accountable for student achievement. These new state standards have begun to supersede local control, mandating specific levels of attainment and specific assessments that would allow the public to compare the successes and failures of schools within the same district or state. At the beginning of the standards movement, academic standards did not extend to pre-school and kindergarten, but this trend is changing (see Bowman, Donovan & Burns, 2000). Several states have now developed standards specifically for young children, and the number of states is sure to grow. For the first time, Head Start—a federally funded programme for at-risk pre-school children—was mandated to identify performance standards for

children. With the growing emphasis on academic performance in pre-school and kindergarten, teachers are now looking for guidance in how to choose instructional practices that are not only developmentally appropriate but also produce consistent achievement gains (Bodrova, Leong & Paynter, 1999).

Along with accreditation and the accountability movement, another trend in early childhood education that influenced the Tools of the Mind project and led to the development of the ELA assessment system was the growing dissatisfaction in the 1990s with standardized assessment, particularly when used to assess young children. Many professional groups—researchers, educators and test makers—began to criticize the use of paper-pencil standardized tests with young children (National Association for the Education of Young Children, 1987; Shepard, Kagan & Wurtz, 1998). Standardized tests were criticized because they were not authentic, tended to underestimate children's knowledge, and penalized children who were from different ethnic and minority groups. In addition, standardized testing often provided little useful information for making classroom decisions. The outcry led to a movement to develop standardized assessment systems (the same procedure is used for all children) that are different from traditional standardized tests. Emphasizing the importance of authentic classroom assessment, these new assessment systems are related more directly to classroom decisions and must be integrated with benchmarks and standards.

Another aspect of the national context that has influenced the implementation of the innovation is the continued diversity of American public schools. The ethnic, cultural, linguistic and social diversity of the American classroom has long been documented in educational research. Few countries have the level of diversity found in the United States. Attempts to respect these differences, while at the same time teaching all children the skills and requisite knowledge to make them productive and literate members of society, have been and continue to be a struggle. The search for innovation has as its highest priority those classroom practices that work with diverse students.

Finally, the national and local context in which the Tools of the Mind project was developed has also been influenced by the growing shortage of experienced teachers. The need to train teachers more quickly has grown. Two trends have been cited as possible causes for this teacher shortage. First, many states have implemented school reforms that reduce class size, particularly in the early grades. Secondly, because of the anomaly of the 'baby boom generation', more practising teachers are retiring, and so there would be a teacher shortage even without reduced class sizes. As a result, teachers are being hired to teach in pre-school and kindergarten with degrees in fields other than early childhood or without experience in the early childhood classroom. School districts are struggling even more than normal with the need to train on the job. Cost-effective ways of conducting in-service training in early literacy has become a top priority.

Specific problematic issues addressed

The Tools of the Mind project was developed to address the following issues facing the educators of young children, from age 3.5 to 7 (pre-school to Grade 2):

- The need for developmentally appropriate teaching techniques to scaffold both underlying cognitive skills and foundational literacy skills for a diverse population of children;
- The need for instruments that combine the best features of standardized and authentic classroom assessments;
- The need for a mechanism to monitor child progress towards standards and to provide timely feedback to teachers; and
- The need for a vehicle for ongoing transfer of expert knowledge to teachers, especially novice teachers.

FIGURE 3. Play plan by Shamiso in May

Vygotsky's theory of learning and development

The theoretical framework that forms the basis of our work is the Cultural-Historical Theory of Lev Vygotsky (1896–1934). Of the many aspects of this theory that profoundly influenced psychological thought in the twentieth century, the Tools of the Mind project primarily focused on the aspects that address issues of learning and development. The revolutionary approach to these issues pioneered by Vygotsky has linked these two processes together in a way that was never before considered. According to Vygotsky, some of the developmental outcomes and processes that were typically thought of as occurring 'naturally' or 'spontaneously' were, in fact, substantially influenced by children's own learning or 'constructed'. Learning, in turn, was shaped by the social-historical context in which it took place. This dual emphasis—on children's active engagement in their own mental development and on the role of the social context—determined the name used to describe the Vygotskian approach in the West—'social constructivism'.

CULTURAL TOOLS AND HIGHER MENTAL FUNCTIONS

The kind of learning (and, consequently, teaching) that leads to changes in development was described by Vygotsky (Vygotsky, 1978) as the situation in which children acquire specific cultural tools, handed to them by more experienced members of society. These cultural tools facilitate the acquisition of *higher mental functions*—deliberate, symbol-mediated behaviours that may take different forms dependent on the specific cultural context.

Higher mental functions exist for some time in a distributed or 'shared' form, when learners and their mentors use new cultural tools jointly in the context of solving some task. After acquiring (in Vygotsky's terminology 'appropriating') a variety of cultural tools, children become capable of using higher mental functions independently. Vygotsky called this progression from the 'shared' to the 'individual' state *the law of the development of higher mental functions* (Vygotsky, 1978).

Tools for higher mental functions have two faces: external and internal (Luria, 1979; Vygotsky, 1978). On the external plane, the tool is one that learners can use to solve problems that require engaging mental processes at levels not yet available to children (e.g. when a task calls for deliberate

memorization or focused attention). At the same time, on the internal plane, the tool plays a role in the child's construction of his/her own mind, influencing the development of new categories and processes. These new categories and processes eventually lead to the formation of higher mental functions such as focused attention, deliberate memory and logical thought.

CULTURAL TOOLS AND THEIR EFFECT ON EARLY LEARNING

The process of learning cultural tools begins in the early years when children first encounter cultural artifacts and procedures associated with using them; they learn to use language first to communicate with other people and later to regulate their own behaviour. This is also the time when they first become participants in 'shared activities'—from the emotional exchanges of infants with their caregivers to the joint problem solving of older children. One of the major outcomes of this process is the ability to take control of their own behaviours—physical, social, emotional and cognitive—through employing their higher mental functions. Vygotsky described this as 'becoming a master of one's own behaviour', as opposed to being 'slave to the environment' (Vygotsky, 1978). In terms of young children's behaviours, this is easy to demonstrate with the example of memory.

In the beginning, children who are not 'armed' with the necessary tools have little or no control over what they can remember and when they can remember it. For these children, these 'whats' and 'whens' are almost totally determined by the environment: a 3-year-old cannot recite a nursery rhyme when asked to do it, but can do it once a teacher starts reciting this rhyme or when this rhyme's character appears on a television screen. This type of spontaneous remembering is governed by the laws of association: children only remember things when they are repeated over and over or continually practised in a fun and engaging activity. While it is possible to employ these rules of association in teaching limited content to very young children, the content demands imposed by formal schooling make it necessary to engage in more efficient and deliberate strategies of remembering. Thus, as a child makes the transition from less formal to more formal learning contexts, the child has to learn how to 'take in a teacher's plan and make it his/her own'. For educators who share Vygotsky's beliefs about the processes of learning and development, the goal of early instructional years involves more than merely transferring specific knowledge—it involves arming children with tools that will lead to the development of higher mental functions (Bodrova & Leong, 1996).

ZONE OF PROXIMAL DEVELOPMENT

The concept of the 'zone of proximal development' (ZPD) is by now quite familiar even to educators working outside the Vygotskian framework. However, the applications of this concept to instructional practice are not numerous, and in many cases the ZPD is used as a metaphor rather than as a theory (Bodrova & Leong, 1996). The ZPD is defined as a distance between two levels of a child's performance: the lower level that reflects the tasks the child can perform independently and the higher level reflective of the tasks the same child can do with assistance.

To successfully apply the concept to instruction, the ZPD has to be placed in a broader context of the Cultural-Historical Theory. It is important to remember that the ZPD reflects the view Vygotskians hold of the relationship between learning and development: what develops next (proximally) is what is affected by learning (through formal or informal instruction). Consequently, the concept of the ZPD is applicable to development only to the degree in which development might be influenced by learning (Vygotsky, 1978). Behaviours having a strong maturational component, for example, could not be described using the ZPD. In addition, for any developments to be influenced by learning, there must be a mechanism that supports the progression of a newly learned/developed process from assisted to individual. In some cases this mechanism is absent and consequently this progression may never occur. This leads us to the next Vygotskian idea that has generated a strong following in the area of education—the idea of scaffolding.

SCAFFOLDING

Although scaffolding is not one of Vygotsky's initial terms, the concept is a useful one because it makes more explicit some of the instructional implications of the idea of the ZPD. Introduced almost forty years after Vygotsky's death by Jerome Bruner (Wood, Bruner & Ross, 1976), scaffolding describes the process of transition from teacher assistance to independence. It answers the frequently asked question about the ZPD: if a child can function at a high level only with assistance, how can this child eventually be able to function at the same level independently?

Scaffolding answers this question by focusing on the gradual 'release of responsibility' from the expert to the learner, resulting in a child eventually becoming fully responsible for his/her own performance. This gradual release of responsibility is accomplished by continuously decreasing the degree of assistance provided by the teacher without altering the learning task itself. Emphasizing the fact that the learning task remains unchanged makes scaf-

folding different from other instructional methods that simplify the learner's job by breaking a complex task into several simple ones. While breaking the task into simple subtasks may work for some areas (demonstrated by some successes of programmed instruction), in other areas, breaking a task into several component tasks actually changes the target skill or concept being learned. This alteration leads to learner difficulty when trying to master complex skills.

In contrast, scaffolding makes the learner's job easier by providing the maximum amount of assistance at the beginning stages of learning and then, as the learner's mastery grows, withdrawing this assistance. However, the question remains: how does a teacher choose the right kind of assistance and then withdraw it in such a way that the student's independent performance stays at the same high level as it was when the assistance was provided? Unfortunately, without an answer to this question, scaffolding will remain more of a metaphor for effective teaching than a description of a specific instructional strategy for teachers to use. In search of this answer, we will turn to the work done within Cultural-Historical Theory by colleagues of Vygotsky and generations of his students.

FIGURE 4. Play plan by Krystine in November

Subsequent developments in the Cultural-Historical Theory as a foundation for instructional practices

Vygotsky first formulated the major principles of the Cultural-Historical Theory, but it took several subsequent decades of work by his colleagues and students to apply these principles to education and to develop new instructional practices based on these principles. Vygotskians elaborated primarily on the idea of 'cultural tools' and were able to identify the specific tools most beneficial for different areas of learning and development. They were also able to describe processes leading to the acquisition of these tools and the role of the teacher in facilitating these processes. These subsequent developments of the Vygotskian approach resulted in the addition of new ideas to the original framework that—along with original Vygotskian concepts—have influenced our work. These ideas include the concepts of the *orienting basis of an action, external mediators, private speech and shared activity* and the idea of *play as a 'leading activity'* (Elkonin, 1977; Galperin, 1969; Leont'ev, 1978; Luria, 1979; Venger, 1988).

ORIENTING BASIS OF AN ACTION

According to Galperin (Galperin, 1969; 1992), 'orienting basis of an action' describes how a learner represents the learning task in terms of the actions he/she will perform in relation to this task. For the learning of a new task to be successful, the learner's actions must be driven by the critical attributes of the task. In identifying these critical attributes, the learner has to deal with a variety of elements that might orient her/him within the task in a more or less appropriate way. Failure to include some of the critical attributes results in errors and may not produce a desired learning outcome. If the learner pays attention to non-essential attributes of the task, he/she may be distracted from the most relevant features, which can also result in errors in learning. For example, if a student does not include the notion of letter orientation in her/his orienting basis of handwriting, letter reversal will result. When the learning task is complex and requires a variety of actions, it is usually difficult for the students to develop the correct and comprehensive orienting basis necessary to succeed. In this case, Galperin suggests that teachers provide scaffolding by first helping students develop the appropriate orienting basis, and then by

teaching students how to monitor their actions using the orienting basis as a reference point. An essential component of scaffolding would include using tangible objects or graphic representations to support the development of an adequate mental representation of the action.

EXTERNAL MEDIATORS

External mediators are among the first tools children use and include tangible objects, pictures of the objects, and physical actions that children use to gain control over their own behaviour. As with all cultural tools the function of the external mediators is to expand mental capacities such as attention, memory or thinking, and to allow the person who uses the tool to perform at a higher level.

In his own writing, Vygotsky (Vygotsky, 1978; 1987) used some examples of external mediators to illustrate the evolution of cultural tools throughout the history of humankind. However, when talking about cultural tools used by modern humans, Vygotsky primarily focused on the language-based tools, although he acknowledged that young children may still need more 'primitive', non-verbal tools. It was through the work of Vygotsky's colleagues Luria, Leont'ev, Elkonin and Galperin, as well as the subsequent generations of Vygotskians, that the role and the development of both verbal and non-verbal tool use by young children was thoroughly investigated (see Elkonin, 1963; Galperin, 1992; Venger, 1988).

PRIVATE SPEECH

With the general emphasis that Cultural-Historical Theory places on language as a universal cultural tool, private speech presents only a small portion of the whole picture. However, private speech is an important language tool a child uses to master his/her own behaviour. A child who uses private speech may seem to be talking to somebody since he or she is talking out loud; however, in reality the only person this child communicates to is him/herself. Thus, private speech is speech that is audible to an outside person but is not directed to another listener. While adults occasionally use private speech, children of pre-school or elementary school age benefit from it most. According to Vygotsky (Vygotsky, 1987), private speech in young children is a precursor of verbal thinking since it serves as a carrier of thought at the time when most higher mental functions are not fully developed. As was later found by Luria (1979), and then confirmed by many studies within and outside the Vygotskian framework, private speech has another important function: it helps children regulate both their overt and mental behaviours (Berk & Winsler, 1995; Galperin, 1992).

SHARED ACTIVITY

Since Vygotsky's works were translated into other languages over more than thirty years ago, the association between Vygotsky's theories and the idea of shared or collaborative activities has been firmly established. However, this association has mainly led to an interest in expert–novice interactions or interactions between peers. In reality, pedagogical applications of this idea go far beyond the issue of optimal instructional interactions. According to Vygotsky, partners in shared activity share more than a common task; they also share the very mental processes and categories involved in performing this task (see the law of the development of higher mental functions, page 9). From an instructional perspective, this means that the mental processes employed by a teacher or by a more experienced peer tutor should be the same ones as would be eventually appropriated by the learner.

Another instructional application of the concept of shared activity applies to a group of mental processes traditionally described under the name of 'meta-cognition' or 'self-regulation'. These essential learning processes are typically studied in older children when they become able to regulate their cognitive functioning. However, from the Vygotskian perspective, the origins of these processes can be found much earlier, when young children start practising self-regulatory functions by regulating other people's behaviour. Thus, engaging young children in activities where they can practise other-regulation as well as self-regulation will contribute to the development of their meta-cognitive abilities (Bodrova & Leong, 1996).

PLAY AS A LEADING ACTIVITY

Symbolic or dramatic play occupies a special place in Vygotsky's theory of learning and development (Berk & Winsler, 1995; Bodrova & Leong, 1996). Play is the activity that is most conducive to development in young children. For children to have the full benefit of play, the play itself must have specific features. For Vygotskians, these features include imaginary situation, roles and rules. While the roles are explicit, the rules that govern the relationship between these roles are typically hidden or implicit. When children enter play they are expected to know what the rules are and the players are only reminded of these rules when they fail to follow them. Thus, as long as everyone follows the same set of rules, these rules will be hidden from an outside observer, which might create an illusion of free-flowing play unconfined by any regulations.

Vygotsky and his colleagues argue that play is not the most unrestricted, 'free' activity, but rather that it presents the context in which children face more constraints than in any other context. Although it is constraining, play is

also one of the most desirable activities of childhood because children are extremely motivated to abide by these limits. Thus, play provides a unique context in which children are motivated to act and at the same time develop the ability to self-regulate their behaviour. The psychological nature of play facilitates the practice of deliberate and purposeful behaviours at a child's highest attainable level (Elkonin, 1977; 1978). As play matures, there is a progressive transition from reactive and impulsive behaviours to behaviours that are more deliberate and thoughtful.

THE LINK BETWEEN THE THEORETICAL FOUNDATIONS AND THE TOOLS OF THE MIND PROJECT

The Vygotskian approach has influenced not only the development of teaching strategies, but also the choice of areas where these strategies are applied and the time at which they are expected to be most effective. The teaching strategies described in the next section directly apply the ideas of the ZPD, scaffolding, external mediators, private speech and shared activity. The idea of the orienting basis of activity was used in identifying the exact procedures and materials needed to implement each of the strategies.

The ideas of the Cultural-Historical framework are also reflected in the design of the ELA. The computerized system is designed to give the best estimate of the child's ZPD and to recommend teaching techniques to provide the optimal level of assistance within this ZPD.

FIGURE 5. Play plan by Krystine in February

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Description of the innovation

In this section, we will describe the innovations created using the Vygotskian framework outlined above. We have selected a sampling of strategies, a description of the ELA computerized assessment system, and a description of the educational videos developed for dissemination.

PLAY AND PLAY PLANNING

True to Vygotskian beliefs about the importance of dramatic play in the development of young children, in our classrooms, dramatic play occupies the central place among daily activities (Bodrova & Leong, 1998a; 1999). Throughout the entire pre-school year and at the beginning of the kindergarten year, elements of dramatic play permeate most of the activities. In addition, pre-school classrooms have a designated dramatic play area where children spend forty to fifty minutes per day in sustained play. Kindergarten children spend closer to forty minutes at the beginning of the year and then as most kindergartens begin more formal instruction in January, the time spent in play in the classroom drops to twenty minutes. Special instructional strategies are used to support all elements of play. In typical early childhood classrooms in the United States, teachers will set aside this amount of time, but children will wander around the room, unable to sustain play. Teachers and school administrators who visit the Tools of the Mind classrooms are surprised at the level of intensity and involvement of the children.

To help children first initiate and then sustain an imaginary situation, the teacher in the project makes sure that the children have a sufficient repertoire of themes that would serve as inspiration for pretend play. To expand this existing repertoire of themes, the teachers use such sources as field trips, visitors' presentations, videos and books. The choice of themes is determined by the children's interests and by the themes already in their repertoire. For example, among themes introduced over several years are space, farm, treasure hunt, store, hospital, veterinarian's office and restaurant.

Props also sustain the imaginary situation. Today's toys so closely replicate their 'grown-up' counterparts (for example, plastic food and toy kitchen utensils) that only when play is at its most mature do children use their imaginations to create props. Many children believe that they cannot play without the specific prop. Instead of pretending the Barbie doll is a dentist, a child will want to buy the 'Dentist Barbie'. In the Tools of the Mind project, teachers try to wean children from the need for specific props by introducing games in

which children think of different ways to play with ordinary objects. They brainstorm ways in which a wooden block can be used—as a baby, a ship or a chair for a doll. Teachers transition children from using realistic props to using minimal props. In playing hospital, for example, a piece of cloth can be used as a nurse's cap, to make a sling for a patient's broken arm or to wrap another patient's sore throat. Children pretend that a bead on a necklace is a stethoscope. Generally, children need only minimal props to indicate the role they are playing and those props can be re-used later for other themes.

To increase the level of mature play, teachers in the project also help children to expand the number of roles in a theme. If children have a limited repertoire of roles or do not quite know what they are supposed to do when acting out a specific role, they cannot sustain dramatic play for a long period of time. For example, if children play hospital they are not limited in their choice by the roles of doctor and patient. They can also play roles such as nurse, pharmacist, x-ray technician or patient's parent. Having such a variety of characters makes play richer in content and also helps prevent children from fighting over one specific role. During field trips or visitors' presentations, teachers focus children's attention on *what* people do and *not* on the objects they use. For example, a visit to a fire station is not likely to lead to a rich play afterwards if children spend all their time exploring the inside of a fire truck. On the contrary, it may even produce conflicts in a play area if there is only one toy fire truck or only one fire-fighter hat. A much more productive use of this field trip would be to introduce children to various activities that people at the fire station are engaged in: answering the phone, driving the truck, putting out fires, administering first aid, etc.

PLAY PLANNING

One of the most effective ways of helping children to develop mature play is to use 'play plans'. A play plan is a description of what the child expects to do during the play period, including the imaginary situation, the roles and the props. Play planning goes beyond the child saying, 'I am going to keep house', to indicate what the child will *do* when he/she gets there such as, 'I am going to play shopping and making dinner' or 'I'm going to be the baby'. Two or more children can plan together if they are interested in playing the same thing or going to the same area. If children want to change their plans, they are encouraged to do so. It is the action of mentally planning that is the major benefit to the child. The figures appearing at the ends of chapters show the progression of play plans for two pre-school children: Shamiso (Figures 1, 2 and 3) and Krystine (Figures 4, 5 and 6). The progression of play plans shown begins with messages dictated to the teacher and ends with the child's attempts to write his/her own message.

In some other early childhood programmes, children plan their activities aloud. However, we found that planning on paper is much more effective than planning orally. Both the children and the teacher often forgot the oral plan. The drawn/written plan is a tangible record of what the child wanted to do that other children as well as that child and the teacher could consult. Many of our teachers take dictation and write what the child dictates about their plan at the bottom of the page, thus turning the planning session into a literacy activity.

For Vygotskians, the external mediation feature of planning on paper strengthens play's self-regulation function. It provides a way for both the child and the teacher to revisit the plan because it serves as a mediator for memory. In creating, discussing and revising their plans, children learn to control their behaviours in play and beyond, thus acquiring self-regulatory skills. Finally, teachers use play planning to influence dramatic play without intervening in and disrupting the play as it is occurring. The teacher suggests to children ahead of time how they can try out new roles, add new twists to the play scenario, or think of a way to substitute for missing props. Potential 'hot spots' are worked out in advance.

In the Tools of the Mind classrooms, play plans increased the quality of child play and the level of self-regulation, both cognitive and social. When teachers did planning every day, children showed gains in the richness of their play. In addition, there was less arguing and fighting among the children. Asking the parties if the argument was 'part of their plan' easily solved the disputes. Of course, they had not planned to argue and immediately returned to their original plan. Arguments seldom blew up into situations where there were power struggles with the teacher. In the long run, after plans had been used for several months, there were few fights since potential problems were defused before the play began.

There are several other benefits to play plans that are worth noting. First, the play plans provided a wonderful way for parents to find out about what goes on in the classroom. They provided a context for parents and children to discuss the day and help parents to feel more involved. Second, the written plans documented the child's progress in both symbolic representation and literacy skills. Third, the plans provide a meaningful context in which to use literacy skills. In our findings, many children began to act like writers by drawing and writing their plan in 'pretend writing' and then telling the teacher what the 'words' meant. For the at-risk children who have not had opportunities to 'write' at home, this is a good place to start literacy activities. Finally, teachers reported that play plans provided a special moment of connection with each child. They gave the teacher time to talk about what the child was interested in doing. The play plans also provided time to talk about what the children had drawn. Although the play plans required ten to fifteen minutes to complete,

once teachers really began using them, they found that the time was well spent. After using plans for only the dramatic play area, many of our teachers ended up using them at other times because they helped children to practise self-regulation in a number of contexts.

SCAFFOLDED WRITING

Scaffolded Writing is a technique invented in the Tools of the Mind project by applying the ideas of the orienting basis of activity, external mediation, private speech and shared activity (Bodrova & Leong, 1996; 1998b). In Scaffolded Writing, a teacher helps a child plan his/her own message by drawing a line to stand for each word the child says. The child then repeats the message, pointing to each line as he or she says the word. Finally, the child writes on the lines, attempting to represent each word with some letters or symbols. During the first several sessions, the child may require some assistance and prompting from the teacher. As the child's understanding of the concept of a word grows, the child learns to carry the whole process independently—self-scaffolded writing—including drawing the lines and writing words on these lines.

The figures appearing at the ends of chapters show how Scaffolded Writing influences writing development. Figure 7 shows a kindergarten-aged child's writing prior to using Scaffolded Writing. Figure 8 shows his first attempt to use scaffolded writing with teacher assistance and Figure 9 shows the same child's self-scaffolded writing two months later.

Through our research, we found that Scaffolded Writing must be implemented differently for children, depending on their background knowledge about literacy. While the major components of Scaffolded Writing—child-generated message, line as an external mediator, private speech engaged during the writing process—remain unchanged, the contexts in which the technique is introduced and then practised might differ. In addition, the particular order of steps children follow when progressing from teacher-assisted Scaffolded Writing to using self-scaffolded writing may also vary.

All children watch the teacher model the use of Scaffolded Writing. The teacher models that the words convey a message and shows the children how to plan the message using the lines. The teachers use messages designed to highlight different aspects of literacy, changing the emphasis as the year progresses. For example, many messages modelled early in the year are used to just reinforce the relationship between spoken and written language—they might be about what is for lunch or what children will do on a particular day. When children are already using the lines on their own, modelled messages highlight meta-linguistic features of words, such as long and short words, or words that

begin with the same sound. Later, the modelled messages are used to teach sound-to-symbol correspondence.

If children have little literacy knowledge, the child's own use of scaffolded writing occurs in specific contexts such as their play plans. The message written usually starts with a stem, such as 'I am going to' or 'My plan is'. After using the stem in the first sentence, children can go on and add more sentences. Children are encouraged as quickly as possible to make their own lines to represent each of the words in their own oral message. At this stage, the teacher focuses on learning voice-to-print match by emphasizing that each word spoken has a corresponding 'line' or representation. A second emphasis is on the idea that writing carries a message. The fact that letters represent sounds is discussed, but children are not expected to write letters and words. They are asked instead to use whatever they wish to help them remember the message—a scribble, a letter-like form or a letter.

When children are familiar to some degree with letters and letter–sound relationships, the procedure adopts a more directed format. This is an evolving process and is individualized to fit the child's emerging skills. The child dictates the message, the teacher draws the lines to stand for the words, and then both the child and the teacher repeat the message, pointing to the line as they say each word. Once the child can repeat the message, the child attempts to write words on the lines. After several sessions of teacher-assisted scaffolded writing, the child is encouraged to try planning the message with the lines all by him/herself. Children are encouraged to write long and complete oral messages to prompt attempts at encoding or writing as many different sounds as possible. Children have a special alphabet chart, called a 'sound map', to help them find the corresponding letter if they do not know it.

At this more advanced stage, children are asked to reread their messages to the teacher after they have finished writing on their own. At this time, the teacher and the child will work on 'editing' the message. Editing consists of working on a certain aspect of literacy at the assisted level. For example, when a child has one phoneme represented in each word of the message, the teacher will help the child hear more sounds by drawing out one of the words. If a child has represented more than one phoneme in the word, the teacher will work on another missing phoneme. In addition, the teacher may reinforce meta-linguistic concepts already introduced in modelled messages. Editing is very individualized and requires that the teacher be very knowledgeable about patterns of literacy development and what kind of assistance would work best with a specific child. At this point, 'estimated spelling' (spelling that is phonologically accurate but not conventionally correct) is acceptable and conventional spelling is not emphasized.

Description of the Early Literacy Advisor

To facilitate the transfer of expert knowledge to the classroom teacher, the Tools of the Mind project developed the ELA system with Dr Dmitri Semenov. Dr Semenov is an expert in mathematical modelling of psychological processes and in the design of artificial intelligence systems. The ELA is conceived as an advisor to the teacher—helping the teacher to assess children more effectively, to analyse assessment data, and to make choices between a number of appropriate teaching techniques. Teachers receive expert advice in the form of individual student profiles that make possible a truly individual approach to address the unique needs and strengths of each student.[1]

Each profile has four parts that could be printed out in any combination. The first part contains the report on the student's performance in a test (such as an overall score and the specific items answered correctly or incorrectly). The second part contains the analysis of error patterns detected in the student's performance. The third part provides the interpretation of these error patterns. The fourth part lists instructional strategies recommended for this particular student.

Expert knowledge derived from research and collective expertise of master teachers is built into each component of the student profile, so that teachers will receive accurate and research-based information. Without fully understanding the expert knowledge behind the recommendations, teachers can still use effective instructional recommendations that would otherwise require attending many hours of in-service training. However, for those teachers who want to become experts themselves, the student profiles provide detailed information about developmental trajectories in literacy acquisition and specific error patterns.

The major components of the ELA include a battery of early literacy assessments, a set of instructional strategies, and computer software designed to interpret the results of the assessment in terms of student literacy development and recommended interventions.

THE ELA ASSESSMENTS

The battery of assessments consists of instruments that target the skills and concepts most critical for early literacy development along with the development of meta-cognitive and meta-linguistic skills. The design of the ELA instruments is based on the Vygotskian principles on the ZPD and scaffolding, and combines assessment of a child's independent performance with the assessment of the child's ability to respond to the teacher's assistance.

An authentic assessment, the ELA uses game-like formats and activities similar to what children would experience in school. Unlike on the typical machine-scored answer sheet used in many assessments, children are not asked to 'bubble in' their answers. Since the assessment battery is designed for non-reading children and emergent readers, adults record the child's actual response on special forms (student response protocols). These forms are then scanned into the computer and processed to generate individual student profiles.

THE ELA INSTRUCTIONAL STRATEGIES

The set of instructional strategies contains new strategies developed within the Tools of the Mind project along with other instructional strategies empirically proven to be effective in supporting early literacy development. Instructional strategies are recommended on basis of the 'window of opportunity' for each strategy estimated to be most beneficial for an individual child. Thus, depending on the assessment results, different strategies could be recommended for different children. To make the strategies' implementation more feasible, similar strategies are grouped into larger categories to be recommended for groups of children with similar instructional needs.

THE ELA EXPERT SYSTEM

The core of the ELA is a proprietary artificial intelligence engine that combines pattern analysis algorithms with an expert system. The expert system is programmed to emulate the decision-making process of master teachers by making connections between an individual student's raw assessment data and effective instructional strategies that are most likely to benefit a particular student at a specific time. In addition, the expert system defines where a child is in the developmental trajectory and estimates the range of skills that will be emerging next. It also identifies the patterns of a child's errors that can be critical in attaining the next milestone in the child's development. The modular design of the expert system makes it applicable to other subject areas and grade levels, but it was first adapted to early literacy instruction.

Thus, the ELA is a logical outgrowth of the previous developments in the Tools of the Mind project designed to facilitate the delivery of its theoretical foundations and effective instructional strategies to classroom teachers. The ELA has been field-tested on over 3,000 children in various samples ranging from pre-kindergarten to Grade 1. Teachers who have used the ELA in their classrooms have found it easy to administer and engaging for the children.

The ELA has been correlated with a general set of standards and benchmarks derived from the most current research on literacy as well as from state documents, documents from professional organizations with set literacy standards, and research reports (e.g. National Reading Panel, 2000; Snow, Burns & Griffin, 1998). From this body of information, a set of general standards and benchmarks were compiled as well as a set of developmental patterns.

DESCRIPTION OF DISSEMINATION MATERIALS AND TEACHING VIDEOS

To increase public knowledge about Vygotsky and the principles on which this project was built, we wrote a book, *Tools of the mind: the Vygotskian approach to early childhood education* (Bodrova & Leong, 1996) and participated in the creation of a video series on Vygotsky with Davidson Films. Three of the teaching videos cover a general introduction to Vygotsky, the role of play in development, scaffolding, and the tactics that are used in teaching—external mediation, private speech and shared learning. The fourth video, which covers literacy, includes much of the Vygotskian approach to the development of literacy.[2]

FIGURE 6. Play plan by Krystine in May

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Implementation of the innovation

The implementation of the Tools of the Mind project can be divided into four phases. The first phase involved our preliminary attempts at adaptation of the Vygotskian approach to the classroom and the creation of new strategies that better fit the American classroom while staying true to Vygotskian theoretical foundations. In the second phase, we attempted to train a large number of teachers to use these strategies. In the third phase, we evaluated the effects of our approach on student achievement and experimented with methods of training teachers. In the fourth phase, we further developed the computerized assessment system, continued to develop strategies and applied them in more diverse settings. In this phase, we worked on aligning the assessment with standards and benchmarks.

PHASE I: ADAPTATION OF VYGOTSKIAN-BASED STRATEGIES TO THE AMERICAN CLASSROOM

The Tools of the Mind project first implemented Vygotskian activities in two classrooms, a mixed-aged classroom with children from kindergarten to Grade 2 (5-7 years of age) and in a large kindergarten class that had three teachers in a private school. Each teacher had more than ten years of classroom teaching experience. These teachers had shown an interest in the techniques and had volunteered to participate.

As we began to implement the strategies, we discovered that many of them did not work when they were imported directly into classroom practices. The classroom practices and the content taught differed substantially. For example, training teachers using the same method to teach reading skills did not translate from Russian to English without major changes to accommodate a different language system. Also, the curriculum in kindergarten and Grade 1 was not the same in different countries. Children in the United States were actually introduced to reading earlier than in the Russian Federation. American children are allowed to attempt to write using 'estimated' spelling before they know all of the sound-to-symbol correspondences and prior to reading, while Russian children are taught to write conventionally from the very beginning. We had to adjust Vygotskian activities so that the content in the activities was meaningful, and we had to synchronize them with American expectations for children of this age. Many of the Russian activities were designed for children who were developmentally much older than their American counterparts, although the learning tasks were similar. Thus, even the level of directions re-

quired to complete the task had to be changed to meet the developmental level of American children since younger children's memory skills are not as advanced.

As a result, we began to create new techniques that used Vygotskian principles but that addressed the needs of American children. Luckily, we were working with a wonderful group of very thoughtful teachers who were able to help us adjust the activities to meet the needs of the American classroom. In fact, these teachers had much higher degrees and more education than teachers in the Russian Federation of equivalent grade levels. This made modifications of our programme much easier. Finding a strong group of practitioners with inquiring minds was crucial to this phase of our project and proved to be very important all the way along.

PHASE II: LARGE-SCALE IMPLEMENTATION AND TEACHER TRAINING

In 1996, we began a massive implementation of our programme in a large urban school district. We worked with seventy-eight teachers in teams in eight schools. The teachers taught pre-school (4-year-olds), kindergarten (5-year-olds), Grade 1 (6-year-olds) and Grade 2 (7-year-olds). We met with small groups of teachers and support staff (special education teachers, reading specialists) for a one-hour session. These sessions were scheduled so that we were able to meet with all seventy-eight teachers once every three weeks. In addition, trained district staff developers provided support in the classroom.

The intensive training process involved in this phase was very time-consuming and yielded inconsistent results. We did not have a full-blown curriculum with teacher manuals and activity kits, and so it was more difficult for teachers to implement our techniques. Teachers who understood and learned the Vygotskian approach did better at implementing the techniques in the classroom. When we gave specific suggestions to teachers, such as after child evaluations, teachers were better able to implement suggestions. Using the assessment data as the basis for teacher training was even more successful than watching the teachers' videotapes of classroom problems. This led us to the idea of making the assessment more closely tied to teaching strategies and developmental patterns.

At the end of the year, the school district administration was reluctant to have the entire project evaluated and blocked the final assessment. The district felt that the assessments should only be given to the children who would pass the test. Otherwise, they argued, it was too painful and difficult for the children. Thus, we were not able to complete an empirical study or even an eval-

uation of our programme. We learned that the word 'evaluation' had different meanings for researchers and school district staff and that this had to be negotiated at the beginning of the project.

However, of the children we were allowed to assess, we found that in those classrooms where our Vygotskian-based programme was faithfully implemented, the children's progress was very strong, much greater than expected. All of the children progressed relative to their initial literacy levels. In addition, progress outweighed the effects of demographic—African-American and Latino students did as well as their Caucasian and Asian counterparts.

During this phase we developed our first three videos.

PHASE III: EVALUATION OF TEACHING STRATEGIES

Realizing the need for a complete and real evaluation of our programme, in Phase III we began an empirical study using control and experimental groups. We narrowed our focus to kindergarten with a small pilot sample of preschools. For the kindergarten study, we worked with a small district with a large population of at-risk children. The plan was to have a six-month trial (January to the end of school) and evaluation of the programme. The preschool programmes were in an urban district.

This marked the first large-scale use of the computerized assessment system. It required that all of the children's assessments (control and experimental) be analysed within a week. By this time the system could analyse an individual protocol and produce a profile in five to ten minutes. More than 500 protocols had to be scanned and analysed in the course of a few weeks. Just the logistics of working this out showed that the computerized assessment system could handle a large volume and still perform flawlessly. The procedures used in this phase of the project and the results of the study are described in the section entitled 'Evaluation'.

The implementation was more successful than we had expected. The children had benefited greatly from the project; even the large number of non-English-speaking students had progressed during the six months to a greater extent than those in the control group. The techniques were successful with at-risk populations. We believed that a more intensive effort would prove them to be even more successful.

The introduction of the computerized assessment allowed us to give less support compared with Phase II, but we obtained more potent results for children. Thus, tying the techniques directly to the assessment speeded up implementation of the teaching strategies.

When we statistically controlled for fidelity to the programme, we found that those teachers who were most faithful in the implementation of the pro-

gramme every week were the ones who had the strongest results, even though their children as a whole began the year at a lower level. These teachers had the greatest gains overall.

In this phase we came across several unexpected problems due to the population we were working with. In some classrooms, 30–60% of the children who began the school year left before the end of the year. A significant number of children were absent for substantial amounts of time—for weeks and months. This complicated issues such as the child's exposure to the techniques as well as data collection for the evaluation.

PHASE IV: CONTINUED DEVELOPMENT OF THE ELA AND ALIGNMENT WITH BENCHMARKS

During this phase, we moved our project to McREL (Mid-Continent Research for Education and Learning), one of ten regional educational laboratories sponsored by the Office of Educational Research and Improvement (OERI) of the United States Department of Education.

The move to McREL increased development of training materials and the degree to which both the assessments and techniques addressed state and national standards for early literacy. This occurred at a time when the field of early childhood education underwent a move to more accountability and the need to address child outcomes. McREL is known nationally for its work in school reform and the development of standards; McREL staff made valuable contributions to the original Vygotskian-based techniques and assessments. At this time, we divided our project into three parts:

- Technique development;
- Dissemination and distance learning; and
- Test and computerized assessment development.

Technique development

We began to work intensively in only two model classrooms as the sites for the development of techniques. We could closely interact with both teachers and children and could receive constant feedback. From this effort, we developed a more coherent curriculum with activities covering more of the components of a pre-school or kindergarten daily programme. With the support of nationally known consultants in reading and early childhood education, the techniques continue to improve and develop as new problems arise.

Dissemination and distance learning

The computerized assessment programme, which included assessments and techniques, became one of the products offered by McREL to school districts

across the United States. The ELA is being used in thirty districts as the accountability measure for kindergarten. Distance training of teachers using the ELA has begun. In addition, we worked with Davidson Films to complete our fourth video to teach early childhood educators about literacy.

Test and computerized assessment development

Test development included setting numerical indicators for the benchmarks using the ELA and the correlation of the assessments with standards and benchmarks. The Best Teachers with At-Risk Children Study, completed in 1999, established numerical indicators for the assessment profiles. For this study, a group of teachers were chosen because of high child achievement scores and school district recommendations. The teachers in the final sample were teaching in schools with a history of very low test scores on standardized assessments in the upper grades and a large number of at-risk children. The computerized assessment was administered at the beginning and at the end of the year. Teachers received all developmental information but did not receive any information about techniques and strategies. The study was designed to identify how far during one year good teachers were able to take at-risk children.

In addition to test development, we have been engaged in an intensive survey of the literature that has resulted in a compilation of the standards, benchmarks and developmental patterns in the area of literacy. These developmental patterns have been used to refine the profiles that were generated from the assessments. The compilation has also been posted on the web for states and school districts to use when setting their own standards.

The primary problem at this time is establishing a stable base of funding for the project. Because the approach to literacy development advocated in the project is not mainstream, it has been difficult to obtain funding through traditional avenues.

Evaluation: selected experimental studies

KINDERGARTEN EVALUATION DATA

In January 1997, the Tools of the Mind project began collaboration with a public school district to improve the underlying cognitive and early literacy skills of kindergarten students. The study was conducted with ten kindergarten teachers—five experimental and five control. Each teacher had two sessions—in the morning and in the afternoon. Each session had twenty to twenty-five students. There were a total of 426 children in the selected schools—218 children in the project classrooms and 208 in non-project classrooms. Experimental and control classrooms were selected so that demographic characteristics of students as well as teachers' educational background and teaching experience would match. In addition, all kindergarteners in the district were given a writing test prior to the beginning of the study. The analysis of the writing samples collected allowed us to make sure that children in the experimental and control classrooms did not differ significantly in their early literacy development.

Teachers implemented three teaching techniques: Scaffolded Writing, written learning plans and sound analysis (using Elkonin boxes and the sound map). We estimate that this comprised (in the best case) about 10% of the classroom instructional time per week. A staff member was assigned to each of the project teachers to assist him/her in implementing these techniques and to collect samples of the children's work. These aides were available for each of the project teachers for one day a week.

To compensate for the extra time during which an aide was available to work with children in the project schools, project staff spent one day a week in the non-project schools doing whatever the teacher asked them to do. For some teachers, this meant reading or writing with the children. In other cases, the staff member freed the teacher up to do other things. In only one case was the aide asked to not participate in the classroom, and so she sat on the sidelines.

Both children in the project and non-project schools attended the IBM *Write to Read* ® lab, a computerized phonics programme. Children in the non-project schools had a literacy period during which they practised writing, looked at books or read a story. This was similar in all kindergartens. Both project and non-project schools were held accountable for a specific set of crucial skills. Children were also assessed using a district-wide assessment.

Children were assessed twice—at the beginning of the semester (January) and at the end of the semester (May). Both times testing was done during a one-week period. Assessments were administered primarily by undergraduate college students majoring in education. About 40% of the children in the project schools were assessed by their teachers. Of all the children participating in the study, 231 were assessed on all assessments—pre- and post-tests. In addition, for some children partial pre- and post-test data were available (e.g. January and May data on the sound-to-symbol correspondence test were collected for 316 children). The significant decrease in the number of children tested in relation to the initial sample size can be attributed to a high turnover rate and high absenteeism typical of urban school districts.

All of the assessments, except the writing sample, were administered in a one-to-one session that lasted about twenty minutes per child. When the writing sample assessment was administered, children began writing in a large group, and then as each child finished, the tester would have the child read his/her writing on an individual basis. Five assessments were given in the pre-test and these five were repeated with two additional assessments in the post-test. The assessments used both for pre- and post-tests were letter recognition, sound-to-symbol correspondence, words versus pictures, instant words and writing sample. Reading concepts and the Venger Graphical Dictation Test, which measured self-regulation, were only administered in spring (Venger & Kholmovskaya, 1978).

Assessment data were analysed using S-Plus statistical software. General accuracy scores were calculated for four assessments: letter recognition, sound-to-symbol correspondence, words versus pictures and instant words. Multiple scales were used to analyse the writing sample and reading concepts tests.

The scales for the writing sample analysis included *scribbling versus writing, number of words, message complexity, word complexity, message decoding, controlled vocabulary usage, accuracy of word encoding, completeness of phonemic representation, correctness of phonemic representation* and *concepts of writing.* The scales for the analysis of the reading concepts data included *voice-to-print match, concept of a word, concept of a sentence* and *comprehension.*

Owing to the time-consuming nature of the manual coding involved in the analysis of the Venger graphical dictation test, analysis of the data collected with this instrument was not completed.

RESULTS

On all pre-tests, the children in the project and non-project schools had very similar distributions on all assessments. Thus, project and non-project samples did not differ statistically on any measures before the introduction of the innovative teaching techniques.

Comparisons of the pre-test and post-test results between the project and non-project schools were made. The students of the project schools demonstrated both higher levels of performance and faster rates of progress than the students of the non-project schools. Significantly stronger growth was documented in several pre-literacy variables most closely associated in the literature with reading achievement in later grades. Overall, children in the project schools performed at higher levels on all measures. In no case did the techniques have a negative effect on development on any scale.

Statistically significant differences between project and non-project classrooms in the area of writing included:

- The number of words written by children who were not writing on the pre-test;
- The number of words written by children who were writing some words on the pre-test;
- Increase in the complexity of the child's written message;
- Better correspondence between the written story and the re-read of that story by the child;
- More consistent use of writing conventions;
- More words that are new and fewer words from controlled vocabulary;
- More accurate spelling; and
- Better phonemic encoding of words that are not a part of the controlled vocabulary.

Statistically significant differences between project and non-project classrooms in the area of pre-reading competencies included:

- Improvement in sound-to-symbol correspondence;
- Better voice-to-print match;
- Better understanding of the concept of a sentence; and
- Better understanding of the symbolic function of a printed word.

In the following areas no statistically significant differences were found between project and non-project classrooms: letter recognition, instant words and words versus pictures. Two of these assessments—letter recognition and words versus pictures—proved to be too easy for most of the children by the end of the year to reliably discriminate between those who made greater progress and those who did not. The instant words measure, on the other hand, appeared to be too difficult even for the end of the year assessment: the median post-test result was only three words recognized out of 100 administered.

Given the comparable performance of children in the project and non-project schools on measures of letter recognition and sight words, the difference in writing at the time of the post-test is even more indicative of the specificity of the techniques used. Although children began at the same initial levels, chil-

dren in the project schools demonstrated significantly higher levels of writing—a strong argument for the effectiveness of Scaffolded Writing, written learning plans and sound analysis.

PRE-SCHOOL DATA

The pre-school project compared two teachers using the Tools of the Mind curriculum with two control classrooms. In project schools all of the children were included in the study, while in non-project schools only about half—those who had permission slips from their parents to be tested—participated. There were a total of seventy-five children in the selected schools, fifty-three children in the project school and twenty-two in non-project schools. All of these children were assessed on all assessments pre- and post-tests. Three assessments—letter recognition, sound-to-symbol correspondence and words versus pictures—were given in the pre-test and these three were repeated in the post-test with the addition of the reading concepts assessment. The pre-test was given in January and the post-test in May.

Assessment data were analysed using S-Plus statistical software. For three assessments—letter recognition, sound-to-symbol correspondence and words versus pictures—general accuracy scores were calculated. For the reading concepts assessment, data were analysed using four scales: voice-to-print match, concept of a word, concept of a sentence and comprehension.

In project classrooms, teachers implemented two teaching techniques: Scaffolded Writing and play plans. These two strategies were typically implemented in a combined fashion and required ten minutes of classroom time daily.

Since the adult–child ratio was higher in pre-school classrooms than in kindergarten classrooms (two adults per eighteen children in pre-school compared with one adult to twenty children in kindergarten) no additional personnel were placed in either project or non-project classrooms.

RESULTS

Since the sub-sample of children from non-project schools was 'self-selected' in the sense that only children whose parents signed permission slips were included, the following procedure was used to make project versus non-project schools comparisons meaningful.

Each child from a non-project school was paired with a child from a project school so that their pre-test scores on letter recognition and sound-to-symbol correspondence tests were as close as possible. This step resulted in twenty-two pairs. On the post-test, data were compared for these twenty-two pairs of children.

The results for both pre- and post-tests are reported for the following measures: letter recognition, sound-to-symbol correspondence and words versus pictures. The reading concepts test was used to compare children from project and non-project schools on the post-test only.

The children in the project school showed statistically stronger growth compared with children in non-project schools in many pre-literacy variables closely associated in the literature with reading achievement in later grades. In no case did the techniques used have a negative effect on development on any scale. Statistically significant increases included:

- Improvement in letter recognition;
- Better sound-to-symbol correspondence;
- Better comprehension of pattern in a text;
- Better understanding of the symbolic function of a printed word; and
- Better separation of a printed word into its component letters.

Thus, the statistical analysis of the results for both groups (kindergarten and pre-school) proved that the innovative teaching techniques used in the project classrooms produced gains in children's early literacy development beyond what was accomplished by the teachers in non-project classrooms. In the absence of comprehensive normative data on literacy development for this age group, it is difficult to evaluate the magnitude of these gains. However, data reported by many researchers in the field suggest that the results demonstrated by the children in the Tools of the Mind classrooms exceed expectations for the respective grade levels, given the demographic characteristics of the samples.

While the data collected provide strong evidence of the innovation's short-term effects, there is not enough data to demonstrate its long-term effects. Collection of follow-up data was made difficult by the fact that participating schools use different instruments to assess reading and writing achievement beyond kindergarten, and thus students' scores could not be compared. The state of Colorado, however, mandates that all fourth graders take the same achievement test. As the two cohorts participating in the study will take this test at the end of fourth grade, we will be able to compare reading and writing scores for children who were initially in project and non-project classrooms.

Although longitudinal data are yet unavailable, teachers' reports provide some encouraging evidence of lasting effects of the innovative teaching strategies on the students. Teachers from the project classrooms quote first and second grade teachers who notice that students who participated in the study are usually more self-regulated learners, express more interest in writing and reading, produce more writing than their peers, and demonstrate mastery of reading and writing at higher levels.

Impact

The reaction of the teachers involved in the project was mainly positive. The teachers who were more intensively involved in the project, and consequently whose results were better in terms of their students' achievement, continued to implement the instructional strategies they learned in the project even if they received less support or no support from the project staff. Their students' scores continued to improve. For example, when the school district began mandating standardized assessments in kindergarten, 97% of students in the project classroom scored at the 'proficient' level, while the average level for the district was 50%. The following year, when the district results were reported in terms of grade levels, students in this classroom scored between 1.4 and 1.8 at the moment of testing. This means that their literacy level in the eighth month of their kindergarten year equalled what was expected by the district to be accomplished only in the fourth or even eighth month of Grade 1. These results are especially impressive given that in this classroom one-third to one-half of the students started the year with limited English proficiency and would usually be placed in an 'at-risk' category on the basis of their socio-economic and demographic characteristics. Teachers attributed their success to the new instructional strategies they were using.

Impact on the local level also included interest and growing support from the school administration. The teachers who participated in the project were invited to speak at local and national conferences and to describe their experiences in articles addressed to classroom teachers.

It is hard to isolate the impact of the innovation on the larger educational community from the impact of other events that were taking place at the same time. However, there is some indication that the scope of the impact of our project has been substantial. For example, the videotapes that explain the theoretical foundations for the project and demonstrate some of the instructional strategies used in project classrooms are currently used in more than 900 colleges and universities nation-wide in their teacher preparation programmes. Local educational agencies and school districts also use the innovations for their professional development workshops. *Tools of the Mind*, which describes the philosophical foundations and the theoretical principles underlying the instructional strategies, remains one of the best-selling books on the subject. We have been invited to speak on early childhood assessment at the national office of the Head Start programme.

The greatest unintended consequence of the project has been increased awareness in the educational community about the potential for early literacy

in pre-school and kindergarten. In our model classrooms, children demonstrate that they can go far beyond current expectations for their age group. In one classroom, which has a particularly high number of at-risk non-English-speaking children, all of the children exceeded the district kindergarten expectations and scored at the Grade 1 level. This was the first time in the district that children from a classroom with this demographic make-up had performed so well.

In addition, the developmental patterns and benchmarks developed in the course of creating the ELA are now being used by other states and school districts to set expectations and standards for young children. As these have been posted on the Internet, the number of people who are interested in them has grown.

Finally, since so many school districts have begun to use the ELA, we have had a chance to collect data from diverse populations in a way we never could before. We are now collecting data from many different types of schools, and we have data from teachers with different levels of implementation to help us refine our tools.

FIGURE 7. Five-year-old Aaron's independent journal writing prior to Scaffolded Writing technique.

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Future prospects/conclusions

Currently, we are working in several arenas. First, we are establishing the reliability and validity of the ELA for younger children through a study of 340 children in a Head Start programme. Head Start is the federally funded early childhood intervention programme for at-risk children. This empirical study will not only show the validity of the assessment battery, but will also validate a number of special early childhood teaching strategies designed to improve both self-regulation and foundational literacy skills. The teaching strategies are heavily play-based and lead into the kindergarten curriculum we have already developed. This study will be completed in June 2001.

We are increasing the quality of the distance training provided through the computerized assessment programme by creating CD-ROM-based training clips to be used in the current training model and eventually to be housed on the Internet.

We have begun to explore the use of the techniques with non-standard-English speakers (African-American Vernacular English) and with non-English-speaking populations (immigrant populations from a number of countries). One of the most interesting results of the last four years of work is that these children make substantial progress in our programme, much more than those children who begin at similar levels without our interventions.

A site licence version of the software system was developed and has been used in thirty school districts, assessing over 1,000 children. In total, the assessment has been administered in various forms for over 3,500 children, and these have all been analysed by computer. This fact shows the promise of the use of the computer as a support to the teacher instead of merely as a teacher replacement. Instead of directly teaching the children, the computer is used to help teachers decide what children need to learn next.

In addition, advances in computer technology have been and will continue to be incorporated into the ELA computer system. For example, the assessments are all JAVA-based, so that they are platform-independent. We will have an Internet-ready version of some assessments available within the year. We are exploring additional kinds of data entry—other than scannable forms—that would still be user-friendly.

The story of the Tools of the Mind project does not end here. We continue to apply the Vygotskian approach to help young children and their teachers. In the future, we hope to extend the types of tools we develop to older children and to other areas of learning.

FIGURE 8. Aaron's writing after the teacher helped him to use the Scaffolded Writing technique.

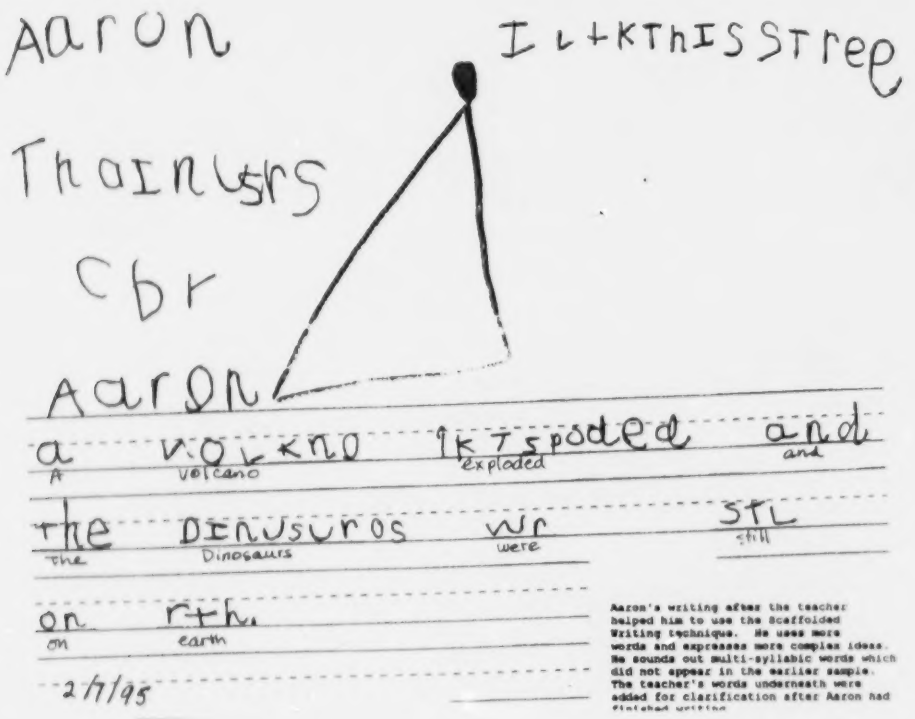
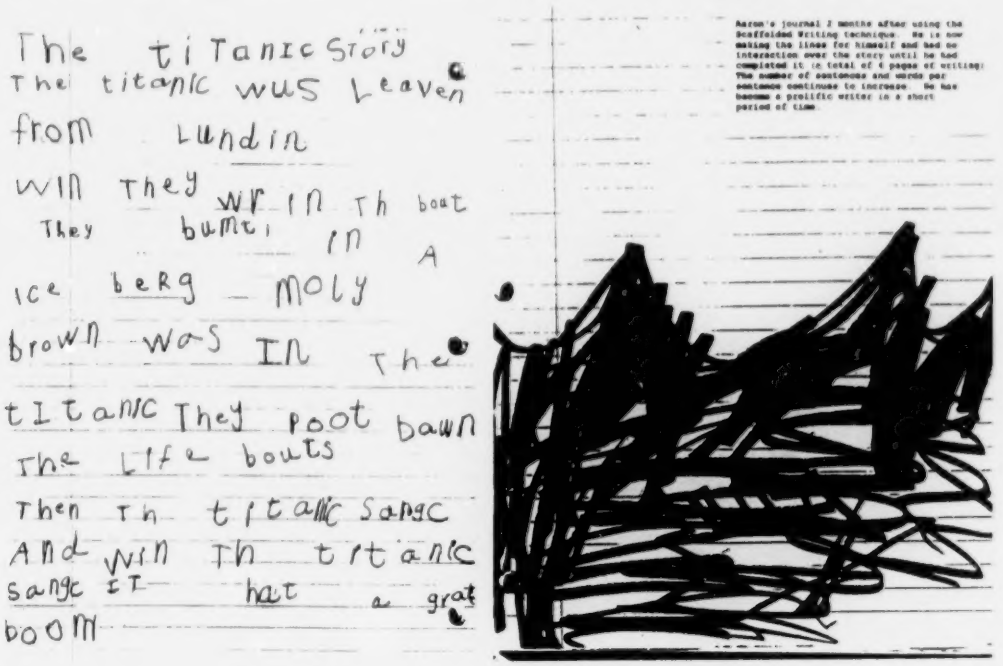

Aaron
I LIKE THIS STEP
Trains
Cbr
Aaron
a volkno exploded and
A volcano exploded and
the DINUSURS wr STL
the Dinosaurs were still
on rth.
on earth
2/7/95
Aaron's writing after the teacher helped him to use the Scaffolded Writing technique. He uses more words and expresses more complex ideas. He sounds out multi-syllabic words which did not appear in the earlier sample. The teacher's words underneath were added for clarification after Aaron had finished writing.

FIGURE 9. Aaron's journal two months after using the Scaffolded Writing technique.


The titanic story
The titanic wus Leaven
from Lundin
wih they wr in th boat
They bumt, in A
ice berg - moly
brown was IN The
titanic They poot bawn
The Life bouts
Then th titanic sange
And wih Th titanic
sange IT hat a grat
boom
Aaron's journal 2 months after using the Scaffolded Writing technique. He is now making the links for himself and had no interaction over the story until he had completed it (a total of 4 pages of writing). The number of sentences and words per sentence continue to increase. He has become a prolific writer in a short period of time.

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Notes

1. http://www.mcrel.org/resources/literacy/ela
2. The titles are *Vygotsky's developmental theory: an introduction; Play: a Vygotskian approach; Scaffolding self-regulated learning in the primary grades*; and *Building literacy competencies in early childhood*. See http://www.davidsonfilms.com

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